DISMANTABLE PROTECTIVE WINDOW

FIELD OF THE INVENTION

This present invention is in the field of protective window systems providing improved protection for individuals and equipment present within a protected space or structure. In particular, the invention is concerned with a blast resistant window system which may be easily removed, e.g. for cleaning and maintenance, and reinstalled in a foolproof manner.

One particular use of such a window system is, for example, for use in preservation buildings wherein it is desired to maintain the original windows and nevertheless provide a blast resistant window protection system. Other use of such systems is for retrofit at any desired window opening.

The term "*window*" as used herein in the specification and claims refers to a variety of window types, e.g. swingable, tiltable casement windows, fixed windows, curtain walls, etc.

BACKGROUND OF THE INVENTION

It is an ever-growing trend by different authorities that old buildings and monuments be preserved so as to maintain the legacy of old ages. Such buildings are often fitted with their original window systems which at times are extremely old and in many cases are no longer suitable for use. Even more so, such window systems may be unstable and loosely fitted within the opening in the wall in a manner which may be dangerous to inhabitants or visitors within the structure. Still another problem concerned in particular with old buildings, but restricted thereto, is the weakness of the walls, which may at times be vulnerable themselves.

It is also an ever-growing requirement to provide public buildings and government institutes with blast-resistant and reinforced window systems suitable for confronting terrorist attacks and the like.

A variety of blast-resistant windows and such window systems are available. However, for most such reinforced systems it is required to remove the original window system which, as mentioned hereinabove, does not suit the present case. Furthermore, it is a requirement that such a reinforced window system may be easily removed, e.g. at times when it is not required to have a reinforced window system, or for exposing the original window, maintenance thereof, cleaning, etc.

It is an object of the present invention to provide a novel reinforced window system which, on the one hand, provides a reliable blast-resistant window system and, on the other hand, is easily fitted into an opening of a wall also in case the opening is pre-fitted with an existing window system. It is a further object of the present invention to provide such a window system which is easily removed and mounted back into place with minimum skill required.

SUMMARY OF THE INVENTION

The present invention calls for a reinforced window system which may be fitted and mounted within an opening in a wall which may already be fitted with a window, e.g. a preservation window, without causing any damage thereto. It is an important feature of the invention that the reinforced window system be adapted for easy mounting and dismounting and that it be capable of absorbing blast energy, to prevent injury and damage from people and equipment within a space in which the window is fitted, even where it is mounted on a weak wall.

According to the present invention, there is provided a reinforced window system for mounting within an opening in a wall, the window system comprising a frame fixable to the opening; said frame comprising an outside support panel and one or more fixable fixing members distributed on an inside of the frame; a reinforced window pane fixedly supported within a removable frame; said removable frame comprising a plurality of support members articulated to the

support frame and adapted for engagement by the corresponding fixing members; and locking members for thereby positioning and fixing the removable frame within the frame.

The window system is fitted with a blast energy absorbing mechanism wherein the support members are formed with at least one arm which at a mounted state of the support frame, extends opposite a corresponding flange associated with the frame, i.e. integral with the frame or otherwise articulated thereto. In accordance with an embodiment of the invention, the flange is a portion of the fixing members adapted for engagement with a corresponding first arm of a support member. In accordance with a further embodiment of the invention the flange is an extension of the frame adapted for engagement with a corresponding second arm of a support member.

By one particular embodiment of the invention, the support members are bifurcated elements having a first arm and a second arm, which arms at a mounted state of the support frame, extend opposite a corresponding portion of the fixing members and an extension flange of the frame.

The arrangement is such that a shock wave striking the window pane gives rise to generation of forces acting in the plane of the window pane and orthogonally thereto, displacing the support frame in an inward, radial direction, whereby the at least one arm of the support members engage the corresponding flanges.

By one particular design of the invention, the window system is a foolproof system, whereby the fixing members and the corresponding support members of the frame and the support frame, respectively, are distributed such that they extend opposite one another only at a correct mounting of the support frame within the frame, or such that only one of the support members there are provided fixing members.

The invention further calls for a framework for a removable reinforced window system comprising a frame fixable within an opening in a wall; said frame comprising an outside support panel and a plurality of fixable fixing members distributed on an inside of the frame; a reinforced window pane fixedly supported

within a removable frame; said removable frame comprising a plurality of support members articulated to the support frame and adapted for engagement by the corresponding fixing members; and locking members for positioning and fixing the removable frame within the frame.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, one preferred embodiment will now be described, by way of anon-limiting example only, with reference to the accompanying drawings, in which:

Fig. 1 is a front view illustrating a portion of a building fitted with a window system in accordance with the present invention;

Fig. 2A is a horizontal section along line II-II in Fig. 1 through a portion of the window in accordance with the present invention;

Fig. 2B illustrates the assembly of a fixing member within a frame of the window system in accordance with the present invention;

Fig. 3 is a schematic front view of a support frame according to the present invention; and

Figs. 4A-4C represent three progressive stages of deformation of a window system in accordance with the present invention.

DETAILED DESCRIPTION OF A PARTICULAR EMBODIMENT

Turning first to Figure 1 of the drawings, there is illustrated a front view of a portion of a building, i.e. from the outside, fitted with a so-called historic window designated **10**, e.g. a window which has been declared as a conservation monument, in itself, or as part of the building **12**. The window **10** is schematically illustrated in Fig. 2 and is supported within an opening **16** of the wall by means of a frame **18**.

When it becomes necessary to install a reinforced window system generally designated **20**, a frame **24** having a general inverted L-like shape with a first arm 25 and a second arm **26**, is fitted with an opening **16** by means of bolts **27**. In the present embodiment, frame **24** is entirely received within opening **16** though it will be appreciated that in other cases the frame may be partially fitted within the opening **16** and partially extending into the room space or, when there is only limited space at the opening, the frame **24** may be fitted on an inside portion of the wall, corresponding with the opening **16**.

As can further be seen in Fig. 2, second arm **26** of frame **24** is formed with a longitudinal receptacle recess **28** extending between two flanged portions **30** and **32**, the latter being shorter than the former for a reason to become apparent hereinafter. The first arm **25** of the frame **24** is formed with an inward projecting flange **36** slightly curved. An end of the first arm **25** of frame **24** is fitted with a groove **38** supporting a resilient sealing member **40**.

Fitted within receptacle group **28** there is a fixing member **46** having an anchoring flange portion **48** formed with a long leg portion **50** and a short leg portion **52** and adapted for insertion into receptacle groove **28** of the frame **24** by displacing it from the initial state illustrated by dashed lines into its final position in the direction of arrow **56** (Fig. 2B). The fixing member **46** has a hook-like flange **60**. A fixing member 46 may extend the entire length of each side of frame **24** or may be segments distributed therealong. Several securing bolts **62** are fitted at the fixing members distributed about the frame **24** in a manner which will securely position and fix the support frame **68** within the frame **24**. It is noted that not all the fixing members **46** are fitted with securing bolts **62**, and the decision how many and where to fit such securing bolts **62**, depends among others on considerations of the ability to absorb blast energy, foolproof mounting (see herein later), etc. Rather then bolts **62** there may be provided locking clamps.

The frame assembly as disclosed herein so far, constitutes a portion which is fixed at the opening **16**. However, the window pane is removable and may be

installed ad hoc, upon demand and may easily be removed, e.g. for maintenance thereof, for reaching the historic window **10** etc.

A window pane designated **64** is in accordance with an embodiment of the invention, a reinforced window consisting of two glass panes with a layer of resin laminate therebetween. However, it is appreciated that the window pane **64** may consist of several different layers and different thickness or may be a homogenous window pane made, e.g. of polycarbonate, imparting it ballistic-resistant. The window pane **64** is fixedly attached to a support frame **68** by an adhesive, e.g. low module silicone **70**, in a manner wherein the window pane **64** is attached to the support frame **68** in a secure manner which will withstand also high shear forces. The arrangement is such that the attachment of window pane **64** to support frame **68** is designed to withstand high shear forces and not to detach. The adhesive material also plays a roll in initial dampening of some of the blast energy forces. However, other mechanic arrangements may suit for that purpose, as known *per se*.

Support frame **68** is integrally formed with an extension **76** which apart from imparting the support frame **68** a higher moment of inertia, it also serves for aesthetic reasons, whereby it conceals the engagement arrangement of the support frame **68** with the frame **24**. A concealing frame panel **80** is removably connected to extension **76** by bolts **62** (or by a suitable locking clamp) and may have different shapes to correspond with the shape and size of the opening in the wall.

Support frame **68** further comprises a receiving groove **84** fitted for receiving with a plurality of support members **88**.

Turning now to a particular embodiment depicted in Figure 3, there is illustrated window pane **64** fitted within the frame **68** where it is noticeable that support members are distributed along edges of the frame in pairs. Each pair consists of a wide support member **90** and a narrow support member **92**, all having the same cross-section as support member **88** in Figure 2. The support members are slidingly received within the groove **84** of frame **68** are fixed in place by various means as known *per se*, e.g. riveting, fixing bolts, etc.

The arrangement is such that the side frame members designated **68s** are fitted with the larger support members **90** adjacent edges of the profiles **68** whilst the top and bottom support frames **68t** and **68b** are fitted with the narrow support members **92** adjacent the edges. This arrangement is adapted for an easy mounting of the support frame **68** within the frame **24** in a foolproof manner, whereby opposite one of the fixing members (each of the narrow fixing members **92**, in the present example), there extends a securing bolt **62** of a fixing member **46**. It is apparent that a myriad of positioning arrangements of the support members and the corresponding fixing members, as well as the distribution of the securing bolts, is possible. For example, support members 90 and 92 at one edge of the window, may be a unitary article. Further distinguishing may be accomplished by different color or other indications.

Reverting now to Figure 2, it is noticeable that the support member **88** is a bifurcated member having a first arm **90** and an opposed, longer arm **92** within an extension therefrom **94**. In the assembled position of the window system, as in Figure 2, first arm **90** extends opposite flange **36** of frame **24** and the second arm **92** extends opposite the hook-like flange **60** of the fixing member **46**. Extension **94** is engageable by securing bolt **62** in a manner which fixes the support frame **68** and secures it in its place bearing against resilient seal **40**.

Thus, it appears that mounting and removing of the frame **68** with the window pane **64** is a simple procedure, whereby it is merely required to release bolts **62** and remove the fixing members **46**, whereby the support frame **68** may be removed. Assembly is obtained in a reverse sequence of operation.

A person versed in the art will appreciate that the number and size, as well as the distribution of the fixing members **46** and support members **88** may vary, depending on the purpose of the window and other considerations.

Furthermore, in order to render the window system also ballistic- resistance, the outward facing arm **25** of the frame **24** may be reinforced or covered by a bullet resistant cover, e.g. a steel frame or other resistant material, e.g. non-woven

ballistic resistant material such as Kevlar™. Such bullet resistant material may be also applied at an inner side of that profile, so it is noticeable from the outside.

Figures 4A-4C illustrate three consecutive stages during a blast caused, e.g. by explosion **Ex** adjacent the building. At a first instance (Fig. 4A), upon occurrence of the explosion, it is highly expected that the historic window **10** breaks. Simultaneously, the blast encountering the outside face of window pane **64** causes it to slightly deform inwardly, entailing deformation of frame **68** in two directions, namely in a radial direction, i.e. parallel to the plane of the window pane **64**, and in a plane orthogonal to the window pane, whereby the extension **94** of the support member **88** shears, or distorts along with the second arm **92**, owing to pressure against the securing bolt **62**.

As the window pane **64** continues to deform inwardly (Fig. 4B), the support frame **68** further deforms in the radial and orthogonal direction until one or both of the first arm **90** and second arm **92** of the support member **88** encounter flange **36** of frame **24** and the hooked flange portion **60** of fixing member **46**. Further deformation of window pane **64** (Fig. 4C) results in deformation of one or both of the first arm **90** and the second arm **92** or, in extreme cases also, of shear thereof. In this manner the blast energy is wasted by converting it into mechanical deformation of the metal frame members.

It is to be appreciated that the support members and/or fixing members may be staggered so as to gradually engage one another, thereby providing increasing force dampening resistance. Also, the first arms **90** and **92**, and the corresponding flanges **36** and hooked flanges **60**, may be pre designed so as to gradually deform or sheer, depending on the required energy dampening effect. Different parameters may be controlled, e.g. length and thickness of the components, imparting them with reinforcement ribs or, contrary thereto, with sheer grooves, etc.

A person skilled in the art will not have any difficulty to understand that the size and shape of the first and second arms **90** and **92** and the second extension **94** of the fixing member, as well as the size and shape of corresponding flanges **36** and

60 may be designed to withstand different magnitudes of forces, taking into consideration the blast resistancy of the window pane.